



# The Digital Earth Reference Model (DERM)

*Interoperability guidance for  
technology implementers*

Dr. John D. Evans  
NASA Digital Earth Office  
June 25, 2001



# What's new in the D.E. Reference Model

- ★ New version 0.5, June 2001
  - ★ <http://www.digitalearth.gov/derm/>
  - ★ *(Previous version 0.3.3, mid-1999)*
- ★ Provides standards guidance to technology implementers (only)
- ★ References D.E.-relevant standards from
  - ★ Int'l Org. for Stds. (ISO), TC211:Geomatics
  - ★ OpenGIS Consortium (OGC)
  - ★ US Federal Geographic Data Committee (FGDC)via hypertext and embedded content

# The new DERM: Organization Viewpoints

Levels of abstraction

*Abstract models*

*What*

*Implementation Specifications*

*How*

*Computation*

*Service invocation*

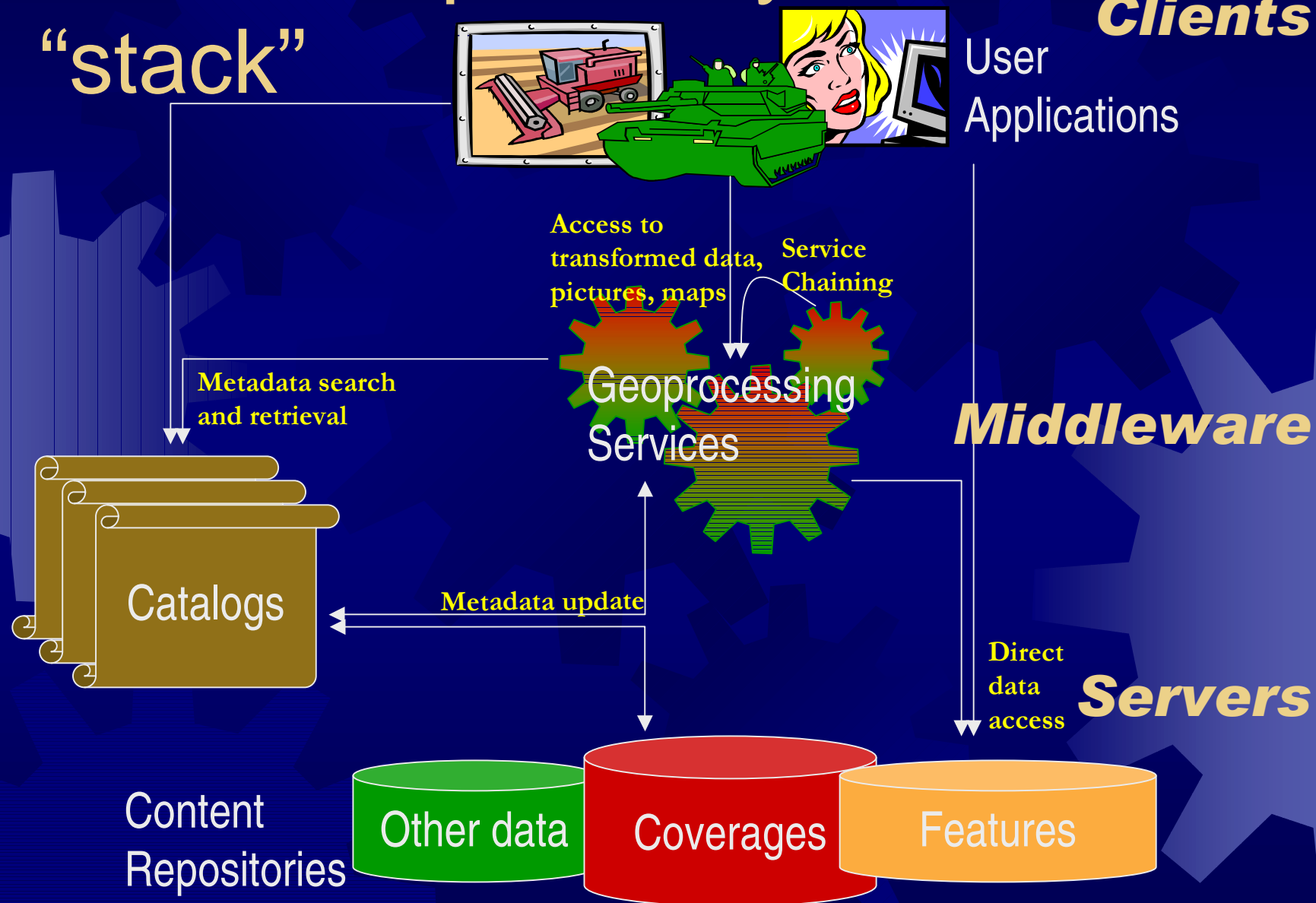
*Information*

*Information transfer*

Behavior	Content
Interface	Encoding

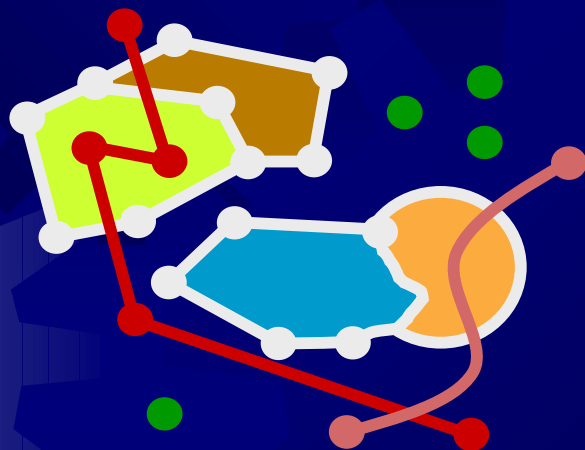
- Abstract model: *theory* -- guidance for design
- Implementation: *practice* -- software “recipes”
- The interoperability “stack”:
  - Data – Services – Applications

# The interoperability “stack”



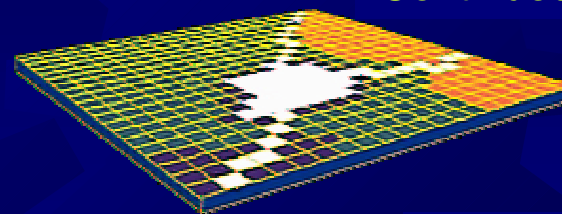
# Geospatial Information Content

## Features

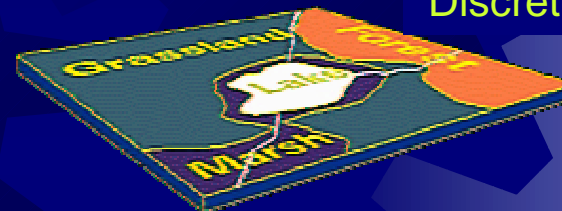


## Coverages

Continuous



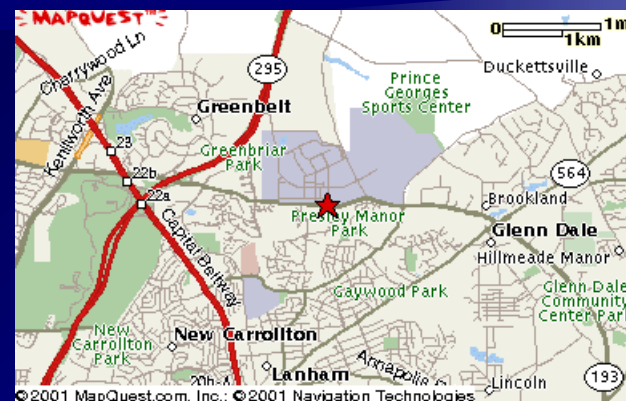
Discrete



## Metadata

Nutrition Facts		Amount/Serving	% DV*	Amount/Serving	% DV*
Serv. Size 1/3 cup (56g)		Total Fat 1g	2%	Total Carb. 0g	0%
Servings about 3		Saturated Fat 0g	0%	Fiber 0g	0%
Calories 80		Cholest. 10mg	3%	Sugars 0g	0%
Fat Cal.10		Sodium 200mg	8%	Protein 17g	
*Percent Daily Values (DV) are based on a diet of 2,000 calories.					
Vitamin A 0% • Vitamin C 0% • Calcium 6% • Iron 6%					

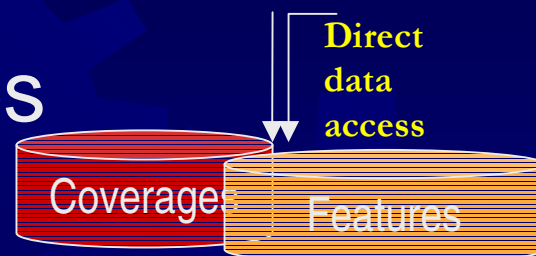
## Maps



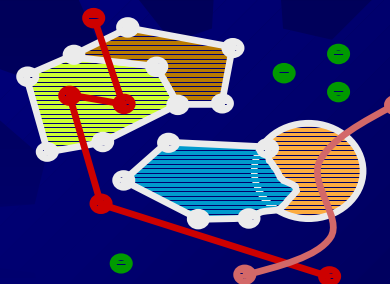


# Data & Data Access

## ★ Features



*Service invocation*



*Information transfer*

*Abstract model  
(what)*

*Behavior:*

OGC Simple Features  
Access, Common  
Model (*ISO 19125-1*)

*Content:*

ISO Spatial Schema (19107)  
ISO Application Schema (19109)  
ISO Feature Cataloguing (19110)  
OGC Feature Geometry (Topic 1)  
OGC Features (Topic 5)  
OGC Feature relations (Topic 8)

*Implementation  
(how)*

*Interface:*

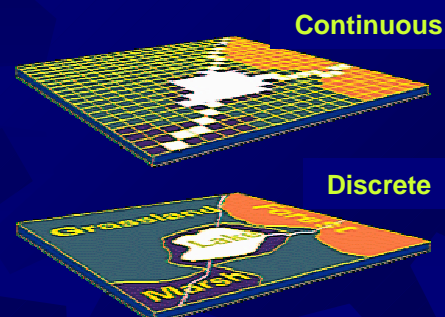
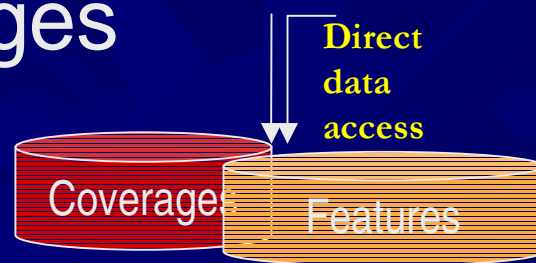
SQL, CORBA, COM:  
OGC Simple Features  
Access  
WWW: *OGC Web  
Feature Service*

*Encoding:*

XML: OGC Geography Markup  
Language [GML]  
GML: *OGC Location Organizer  
Folder*

# Data & Data Access (cont.)

## ☀ Coverages



### Service invocation

### Information transfer

*Abstract model  
(what)*

*Implementation  
(how)*

*Behavior:*

**OGC Coverages (Topic 6)**

*Content:*

***ISO Coverage Schema (19123)***

*Interface:*

**OLE/COM, CORBA:**  
OGC Grid Coverages  
Impl. Spec.

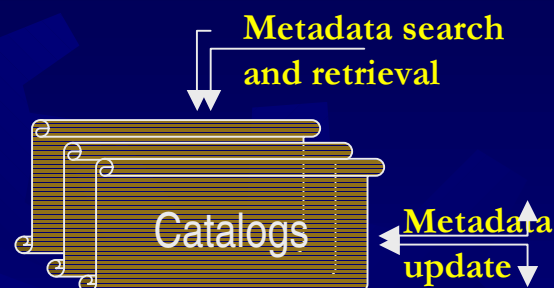
*Encoding:*

**GeoTIFF, HDF-EOS,  
DTED, NITF, CDF**

**WWW: OGC Web  
Coverage Service**

**XML: XDF, ESML, OGC  
GML-Coverages**

# Metadata & Catalogs



Nutrition Facts		Amount/Serving	% DV*	Amount/Serving	% DV*
Srv. Size 1/3 cup (56g)		Total Fat 1g	2%	Total Carb. 0g	0%
Servings about 3		Saturated Fat 0g	0%	Fiber 0g	0%
Calories 80		Cholest. 10mg	3%	Sugars 0g	
Fat Cal.10		Sodium 200mg	8%	Protein 17g	
*Percent Daily Values (DV) are based on a 2,000 calorie diet.		Vitamin A 0%	Vitamin C 0%	Calcium 6%	Iron 6%

*Service invocation*

*Information transfer*

*Abstract model  
(what)*

*Behavior:*  
OGC Catalog Services  
(Topic 13)

*Content:*  
FGDC Content Standard  
ISO 19115, Metadata  
OGC Metadata (Topic 11)  
*ISO 19119, Services*

*Implementation  
(how)*

*Interface:*  
CORBA, OLEDB, Z39.50-  
WWW: OGC Catalog  
Services Implem. Spec.  
WWW (stateless): OGC  
Web Catalog Service

*Encoding:*  
XML DTDs: ISO 19115;  
FGDC; *OGC Web  
Catalog Service*

✱ Metadata may describe *data* or *services*



# Coordinate Reference Systems

## *Information transfer / Service invocation*

### *Abstract model (what)*

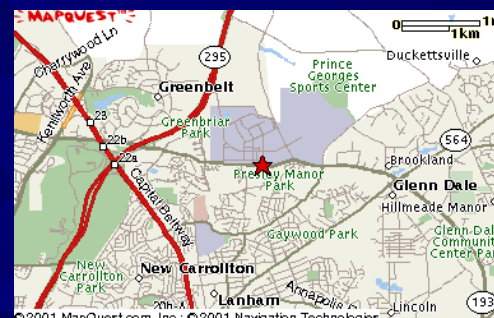
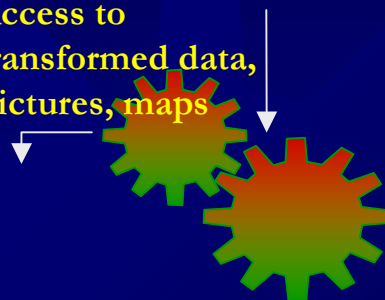
ISO Spatial Referencing by Coordinates (19111)  
OGC Spatial Reference Systems (Topic 2)  
*OGC Recommended Definition Data for Coordinate  
Reference Systems & Transformations*  
ISO Temporal Schema (19108)

### *Implementation (how)*

EPSG Coordinate Reference Systems database  
OGC Well-Known Text  
OGC Coordinate Transformations Impl. Spec.  
*OGC Units of Measure Recommendations (XML)*  
ISO Representation of dates & times (8601)

# Maps & visualization

Access to  
transformed data,  
pictures, maps



*Abstract model  
(what)*

*Service invocation*

*Information transfer*

*Behavior:*  
OGC Web Map Service  
(Interactive Portrayal)  
(ISO 19128)

*Content:*  
ISO Portrayal (19117)

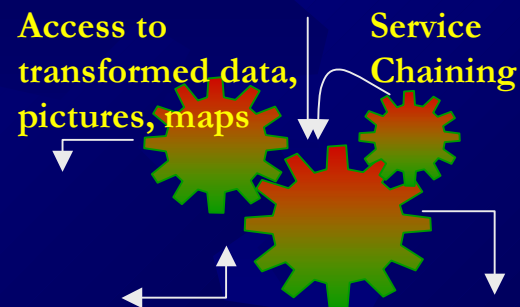
*Implementation  
(how)*

*Interface:*  
WWW: OGC Web Map  
Service

*Encoding:*  
XML: OGC Styled Layer  
Descriptor  
GeoTIFF, SVG, PNG, JPEG,  
*etc.*

# Geoprocessing services

## ☀ General model



*Service invocation*

*Information transfer*

*Abstract model  
(what)*

*Implementation  
(how)*

*Behavior:*

*ISO Services (19119)*

*Interface:*

*WWW/XML: OGC Basic  
Services Model;  
SOAP; WSDL; UDDI*

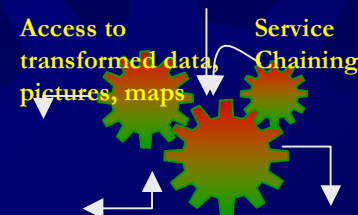
*Content & Encoding:*

*[Geometries, features,  
coverages, objects,  
coordinates, text, etc.]*



# Geoprocessing Services

## ★ Coordinate transformations



### *Service invocation*

### *Information transfer*

*Abstract model*  
(what)

*Behavior:*

ISO Spatial Ref. by Coordinates (19111)  
OGC Spatial Reference Systems (Topic 2)  
OGC Recommended Definition Data for Coordinate  
Reference Systems & Transformations

*Content:*

[Features &  
coverages]

*Implementation*  
(how)

*Interface:*

EPSG/POSC Coordinate Ref. Systems  
OGC Well-Known Text  
OGC Units of Measure Recommendations

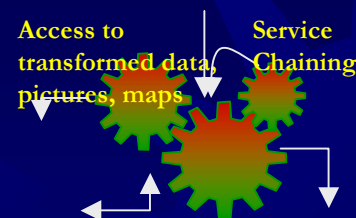
*Encoding:*

[Features &  
coverages]

(Coordinate  
Reference  
Systems)

COM, CORBA, Java: OGC  
Coordinate Transformation  
Impl. Spec.  
*OGC Image Coordinate  
Transformations*

# Geoprocessing Services



## ★ Gazetteer

*Service invocation*

*Information transfer*

*Abstract model  
(what)*

*Behavior:*  
ISO Geographic referencing by  
identifiers (19112)

*Content:*  
[IDs, Features]

*Implementation  
(how)*

*Interface:*  
WWW/GML: OGC Gazetteer  
Service  
XML: OGC Geoparser Service,  
OGC Geocoder Service

*Encoding:*  
[Text, Features]

## ★ Other geoprocessing services

- ★ Image classification & feature extraction
- ★ Network routing, etc.





# D.E. Reference Model: summary

- ✦ DERM is a geospatial interoperability guide
  - ✦ Implementation specs to use if applicable
  - ✦ Abstract models to follow otherwise
- ✦ Behavior / Interface – Content / Encoding for
  - ✦ Data and data access:
    - Features - Coverages
  - ✦ Metadata and catalogs
  - ✦ Maps and visualization
  - ✦ Coordinate reference systems
  - ✦ Geoprocessing services:
    - Coordinate Transform. - Gazetteer - Others



# The GSDI Cookbook

☀ Advice for building Spatial Data Infrastructures

1.	Overview
2.	Shared framework data: ISO 19109, 19110
3.	Metadata: FGDC, XML, ISO 19115
4.	Search & discovery: ISO 23950, OGC Catalog
5.	Visualization: WMS1.0, available software
6.	Repository access & exchange formats
7.	Other services
8.	Outreach; funding; institutionalization
9.	Case studies (local, national, regional, global)



- 16

# Embedded sidebars: example

The new Digital Earth Reference Model - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites History

Address <http://sneezy.gsfc.nasa.gov/v05.php4> Go Links

## 2. Metadata & Catalog access

By describing data or services, metadata aid their discovery by users, and their widespread use within an interoperable infrastructure. Metadata are usually stored in a catalog, and accessible to applications and services via catalog interfaces. The [GSDI Cookbook](#) ([Chapter 4, section on "Relevant standards"](#)) provides a concise overview of standards for access to metadata through catalog interfaces, and for metadata content and encoding.

	Service Invocation	Information Transfer
Implementation specifications	Interface: OGC Web Registry Server DCIS OGC Catalog Services I.S. ISO 23950 (ANSI Z39.50), GEO profile	Encoding: OGC Web Registry Server DCIS ISO DIS 19115 (Metadata XML encoding)
Abstract models	Behavior: OGC Topic 13, Catalog Services	Content: FGDC Content Standard ISO DIS 19115, Metadata

Table 4. Catalogs and metadata

### Implementation specifications

Two OGC specifications define catalog access in implementable detail:

- OGC's [Catalog Interface](#) Implementation Specification defines an SQL-like Common Query Language for search and retrieval of metadata, along with profiles of it for the OLEDB, CORBA, and Web computing environments. The Web profile uses [ANSI/NISO Z39.50](#) (a.k.a. ISO 23950) services, either on its own Internet port, or via HTTP using XML-encoded requests and an HTTP "cookie" to maintain state across a client session.
- OGC's [Web Registry Server](#) informal Discussion Paper (OGC Doc. 01-024r1) sketches a Web-oriented stateless catalog interface.

As for metadata encoding, XML is generally the preferred option; several standards provide document structures (DTDs):

- ISO's [Metadata](#) draft standard, Annex F (ISO 19115 / DIS: 2001-04; FDIS: 2001-11, IS: 2002-01) provides a DTD for dataset metadata, auto-generated from a UML model.
- FGDC provides an earlier, simple [DTD](#) that conforms to its Content Standard (see below), also for dataset metadata.
- OGC's [Web Registry Server](#) informal Discussion Paper (OGC Doc. 01-024r1) proposes an XML DTD for service metadata elements applicable to OGC's Web Map Service, Web Feature Service, and Web Coverage Service.

From the GSDI Cookbook:

### The Benefits of Metadata

Metadata helps people who use geospatial data find the data they need and determine how best to use it. Metadata benefit the data producing organisation as well as personnel change in an organisation, undocumented data may lose their value. Later workers may have little understanding of the contents and uses for a digital database and may find they can't trust results generated from these data. Lack of knowledge about other organisations' data can lead to duplication of effort. It may seem burdensome to add the cost of generating metadata to the cost of data collection, but in the long run the value of the data is dependent on its documentation.

Metadata is one of those terms that is conveniently ignored or avoided. However there is an increasing recognition of the benefits and requirement for metadata for our data as we continue to increase the use of digital data. Whereas cartographers rigidly provided metadata within a paper map's legend, the evolution of computers and GIS has seen a decline in this practice. As organisations start to recognize the value of this ancillary information, they often begin to look at incorporating metadata collection within the data management process.

(more)

★ Main DERM text

★ Text from GSDI Cookbook (fetched via PHP)



# Where to from here

- ★ The DERM is an evolving document
  - ✱ New standards & technologies
- ★ The DERM and GSDI Cookbook will undergo further integration
  - ✱ US Digital Earth / FGDC alignment
- ★ The DERM is a consensus document
  - ✱ Needs your input!
- ★ <http://www.digitalearth.gov/derm/>